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STUDIES OF FILARIASIS IN KEBAN AGUNG AND GUNUNG AGUNG VILLAGES IN SOUTH BENGKULU, SUMATERA, INDONESIA : I

The mosquito fauna with reference to seasonal studies of two *Anopheles* and *Culex tritaeniorhynchus* *

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INTRODUCTION

A large number of reports on mosquitoes of Sumatera and neighbouring islands reveal that 198 species have thus far been discovered (Brug & Haga, 1923; Brug, 1931; Brug & Edwards, 1931; Swellengrebel & Rodenwaldt, 1932; Brug, Bonne-Wepster, 1947; Bonne-Wepster & Swellengrebel, 1953; Bonne-Wepster, 1954; Waktoedi, 1954; Reid, 1968; Lien et al., 1975). All these report were based on short-term surveys, and most were from South Sumatera. Longitudinal studies of mosquito vectors of malayan filariasis during this study for a 24-month period in two villages were carried out. All mosquito species were collected, identified and recorded. The present paper presents the mosquito fauna in the study areas, and discusses (1) the seasonal variations of *Culex tritaeniorhynchus, Anopheles peditaeniatus,* and *An. nigerrimus,* and (2) the parous rate of two *Anopheles* species.

STUDY AREA

Bengkulu province is situated in southwest of Sumatera. It has a population of about 650,000 and covers an area of 20,000 km^2. The study area is situated in Marga Andalas (3°55' S – 102°25' E), which is 60 km from Bengkulu city. The biotypes range from coastal swamp regions through cultivated areas and thence through undeveloped inland areas of scrub and forest up to the mountains. A field station is situated in Cahaya Negri (Fig. 1). Keban Agung is 20 km southwest, and Gunung Agung is 24 km southeast from the field station. Keban Agung lies in a flat land, surrounded by secondary vegetation, such as rubber trees, scrub, and fruit plantations. The outskirts are swampy ricefields with secondary forests. Gunung Agung lies on the foothill, surrounded by secondary forests. There are small patches of swampy ricefields in the village, and also patches of forest swamps abound. In both these villages domestic animals, such as cattle, water buffaloes, goats, dogs and cats are common. In the surrounding forests, wild monkeys, such as *Presbytis cristata* and *Macaca fascicularis* are also very common.

MATERIALS AND METHODS

Landing collections of mosquitoes were carried out for 24-months, from April 1979 to March 1981 in Gunung Agung and Keban Agung villages. Six mosquito scouts, three collecting indoors, and three outdoors, caught mosquitoes landing on humans from 6–10 p.m. every month in each of the villages. Mosquitoes were sucked into aspirators and transferred into paper cups, held overnight, and examined the next morning after being killed with ether. They were then sorted out into generic groups,

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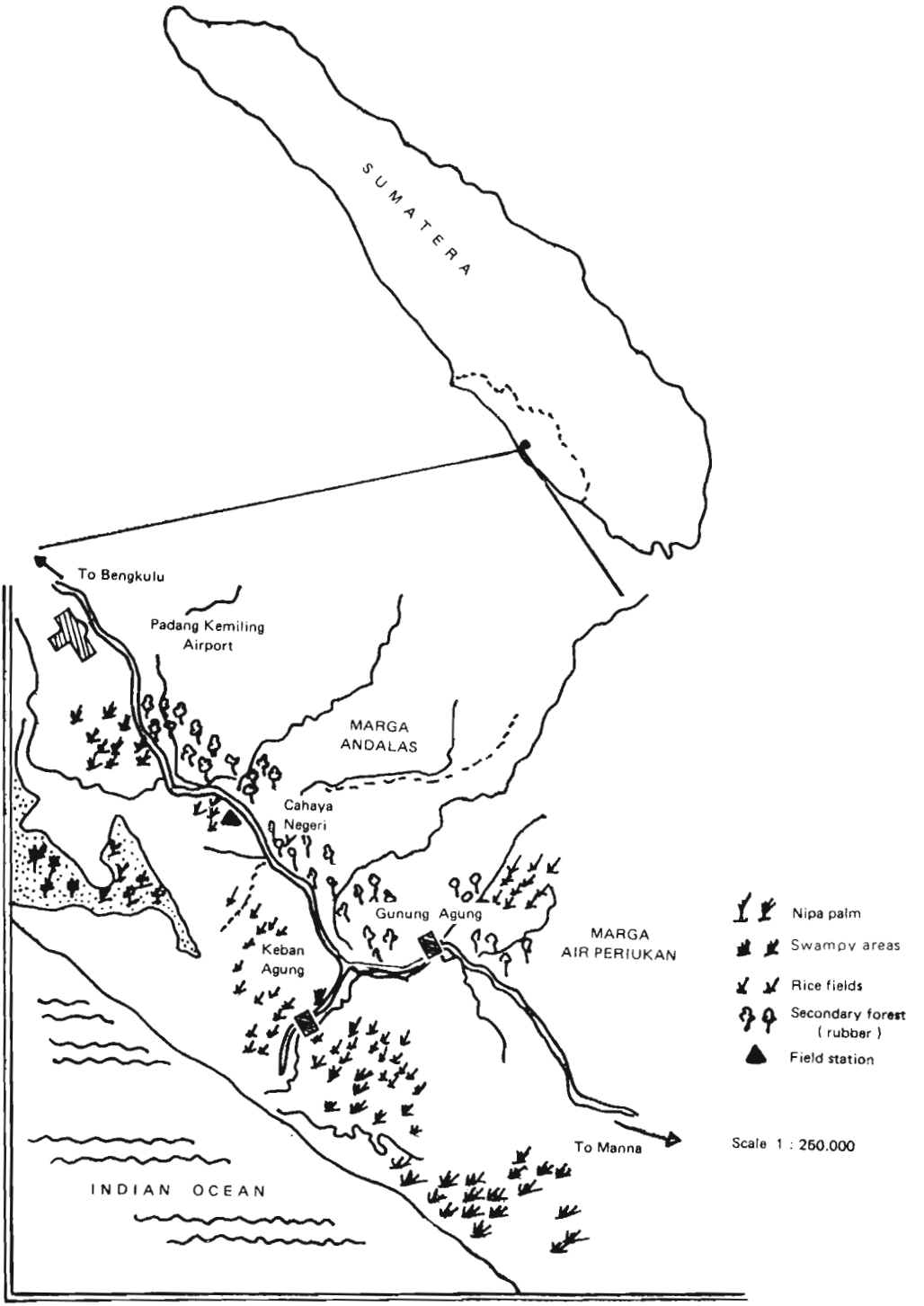
Fig. 1. Map showing study areas in Southwest Bengkulu, Sumatera, Indonesia.



and individually identified. A reference collection of each species was made, and doubtful specimens were referred to specialists for confirmation of the identification.

Collections of landing mosquitoes were made twice a month at alternate weeks in each village. Parous rates of *An. nigerrimus* and *An. peditaeniatus* were determined by ovarian dissection.

The monthly rainfall data in the study areas were obtained through the meteorogical station at Bengkulu. These were plotted against the monthly mosquito catches expressed in mean number mosquito man/hour per month to assess seasonal variations of three mosquito species, and seasonal parity studies of the two *Anopheles* species. For statistical analysis, the coefficient correlation test was used.

RESULTS

MOSQUITO FAUNA

A total of 46,975 mosquitoes were collected and examined, these comprised 30.0 % from Gunung Agung as compared to 70.0 % from Keban Agung. In Gunung Agung 43.6 % of the catches were from indoors compared to 56.4% from outdoors, while in Keban Agung indoor catches were 33.9 % as compared to 66.1 % from outdoors. Six genera with 32 mosquito species were examined from Keban Agung, and 30 from Gunung Agung villages. These consisted of 5 *Mansonia* spp., 11 *Anopheles* spp., 3 *Coquilletidia* spp., 9 *Culex* spp., 3 *Aedes* spp. and 1 *Armigeres* sp. Among these, *Mansonia* spp. comprised 37.0 %, *Anopheles* spp. 19.2 %, *Coquilletidia* spp. 1.7 %, *Culex* spp. 40.8 %, *Aedes* spp. 1.1 % and *Armigeres* sp. 0.2 % of the total catches in both areas combined.

The percent frequency distribution of these mosquito spp. are remarkably similar in each of the villages (Table 1). *Culex* spp. were shown to have the highest prevalence rate. The prevalence ratio between Keban Agung and Gunung Agung for *Mansonia* was 2.2 : 1, *Anopheles* 4.4 : 1, *Coquilletidia* 1.9 : 1, *Culex* 1.6 : 1 and *Armigeres* 7.6 : 1 respectively.

Four out of 5 *Mansonia* spp. examined except *Ma. annulifera* were very common in both the villages. The mean number of mosquito per man-hour was highest for *Ma. bonneae* in Gunung Agung and for *Ma. annulata* in Keban Agung (Table 1). The lowest index was that of *Ma. annulifera.* Among the 11 *Anopheles* spp. collected in both villages, the highest index was that of *An. peditaeniatus,* followed by *An. nigerrimus.* The density of other *Anopheles* spp. was found in relatively small numbers (Table 1). For *Coquilletidia* spp., *Coq. nigrosignata* had the highest index of the 3 species examined, and among the 9 *Culex* spp., *Cx. bitaeniorhynchus* was the most predominant in each of the villages. The indices of *Aedes* and *Armigeres* spp. were very low in both the villages (Table 1).

A total of 7,352 *Anopheles* and 12,719 *Culex* were collected and examined both from indoor and outdoor landing collections from Keban Agung. Of the *Anopheles* mosquitoes, 25.2% were *An. nigerrimus* and 70.4 % *An. peditaeniatus,* and *Cx. tritaeniorhynchus* comprised 61.9 % of all *Culex* mosquitoes examined. Of 1,669 *Anopheles* collected from Gunung Agung, *An. nigerrimus* consisted of 37.9 % and *An. peditaeniatus* 47.6 %, and *Cx. tritaeniorhynchus* was 67.1 % of 6,438 *Culex* examined.

SEASONAL VARIATIONS OF THREE SPECIES OF MOSQUITOES

In Keban Agung (Fig. 2) *Cx. tritaeniorhynchus* is negatively correlated with rainfall, the correlation coefficient is r = 0.475. There seems to be a major peak in December through February. The 1979–80 peak was considerably higher than that of 1980–1981. A secondary peak was observed from June through August. In Gunung Agung (Fig. 3) the mosquito shows the same peak phenomena, but less markedly than that in Keban Agung. The major and minor peaks of 1980 were about equal. There was an inverse correlation between rainfall and density in Gunung Agung, the correlation coefficient is r = 0.680.

Table 1. % Frequency distributions of mosquito-fauna collected in nocturnal indoor and outdoor landing catches in two villages, south Bengkulu, Sumatera, Indonesia.
(Figures expressed in number mosquito/man-hour)

Mosquito species	Gunung Agung		Keban Agung	
	Indoor	Outdoor	Indoor	Outdoor
MANSONIA				
Ma. annulata	0.45	0.61	1.37	2.20
Ma. bonneae	0.84	1.07	0.91	2.21
Ma. dives	0.39	0.66	0.48	1.19
Ma. uniformis	0.27	0.39	0.69	1.31
Ma. annulifera	0.	0.01	0.01	0.02
total	1.95	2.74	3.46	6.93
ANOPHELES				
An. nigerrimus	0.25	0.29	0.59	1.01
An. peditaeniatus	0.29	0.39	1.60	2.89
An. philippinensis	0.04	0.06	0.15	0.02
An. aconitus	0.01	0.03	0.01	0.01
An. argyrapus	0.01	0.01	0	0.01
An. kochi	0 01	0.01	0.01	0.01
An. sinensis	0	0.01	0.01	0.01
An. vagus	0.01	0	0	0.01
An. tesselatus	0	0.02	0.01	0.03
An. barbirostris	0	0	0	0.02
An. minimus	0	0	0	0.01
total	0.61	0.82	2.38	4.02
COQUILLETIDIA				
Coq. nigrosignata	0.16	0.18	0.11	0.04
Coq. crassipes	0.01	0	0	0.01
Coq. aurosquamata	0	0.01	0.03	0.19
total	0.17	0.19	0.14	0.24
CULEX				
Cx. tritaeniorhynchus	0.17	0.24	0.29	0.63
Cx. quinquefasciatus	0	0.01	0.01	0.01
Cx. fuscocephala	0.01	0.01	0.05	0.02
Cx. gelidus	0.26	0.21	0.24	0.35
Cx. psuedo-vishnui	0.01	0.02	0.02	0.04
Cx. sinensis	0.01	0.06	0.09	0.38
Cx. bitaeniorhynchus	0.65	2.10	2.25	0.59
Cx. vishnui	0.30	0.41	0.64	1.36
Cx. whitemorei	0.01	0.01	0.01	0.03
total	2.42	3.07	3.60	3.41
AEDES				
Ae. albopictus	0.03	0.02	0.05	0.05
Ae. lineatopennis	0.01	0.01	0.01	0.06
Ae. vexans	0.04	0.04	0.02	0.09
total	0.08	0.07	0.08	0.20
Armigeres sp.	0.01	0.01	0.02	0.05
Total number examined	6159	7969	11,130	21,717

An. peditaeniatus in Keban Agung (Fig. 2) shows a slight peak from September through November, but the correlation coefficient test (r = 0.256) shows there was no significant correlation with rainfall. In Gunung Agung (Fig. 3) no consistency in seasonal fluctuation could be detected, since this species showed a slight peak in September through October in 1979, but did not show in 1980. Like in Keban Agung, there was no correlation with rainfall (r = 0.254). No marked seasonal variation was observed for *An. nigerrimus* in Keban Agung (Fig. 2) as well as Gunung Agung (Fig. 3).

PAROUS RATES OF AN. NIGERRIMUS AND AN. PEDITAENIATUS

In Keban Agung 42.4% of 1,131 *An. nigerrimus* and 46.7 % of 2,738 *An. peditaeniatus* were parous as compared to 45.1 % of 674 of the former and 51.0 % of 847 of the latter species from Gunung Agung during the 24-month observation period. The parous rates of *An. nigerrimus* combined from both areas ranged from 25.4 % to 73.9 % (av. 49.5 %) as compared to *An. peditaeniatus* which ranged from 26.3 % to 81.8 % (av. 51.6%). The parous rates of *An. nigerrimus* from Keban Agung (Fig. 4) seems to show an inverse correlation with density, however the correlation coefficient (r = 0.615) is not significant. There was no observable relationship of the parous rates with rainfall, the correlation coefficient is r = 0.339. Like in Keban Agung the parous rate of this mosquito from Gunung Agung (Fig. 5) also seems to show an inverse correlation with density, but the correlation coefficient (r = 0.466) is not as great as that from Keban Agung. With regard to *An. peditaeniatus*

Fig. 2. Seasonal variations of *Culex tritaeniorhynchus, Anopheles peditaeniatus* and *An. nigerrimus* in Keban Agung village, Southwest Bengkulu, Sumatera, Indonesia.

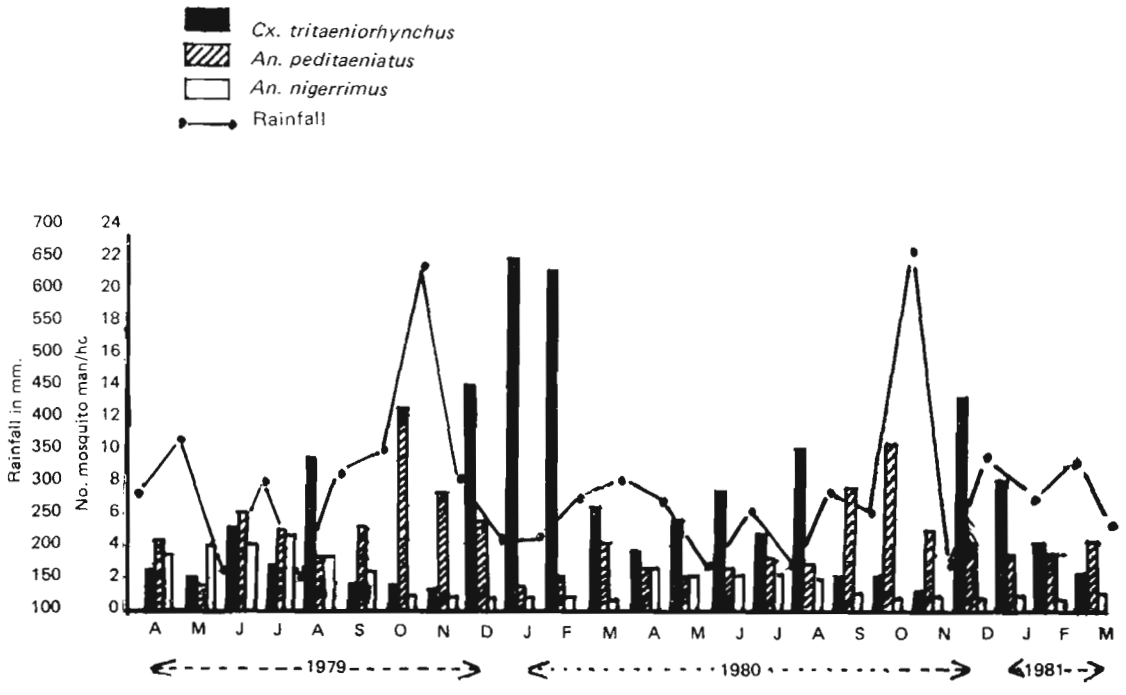
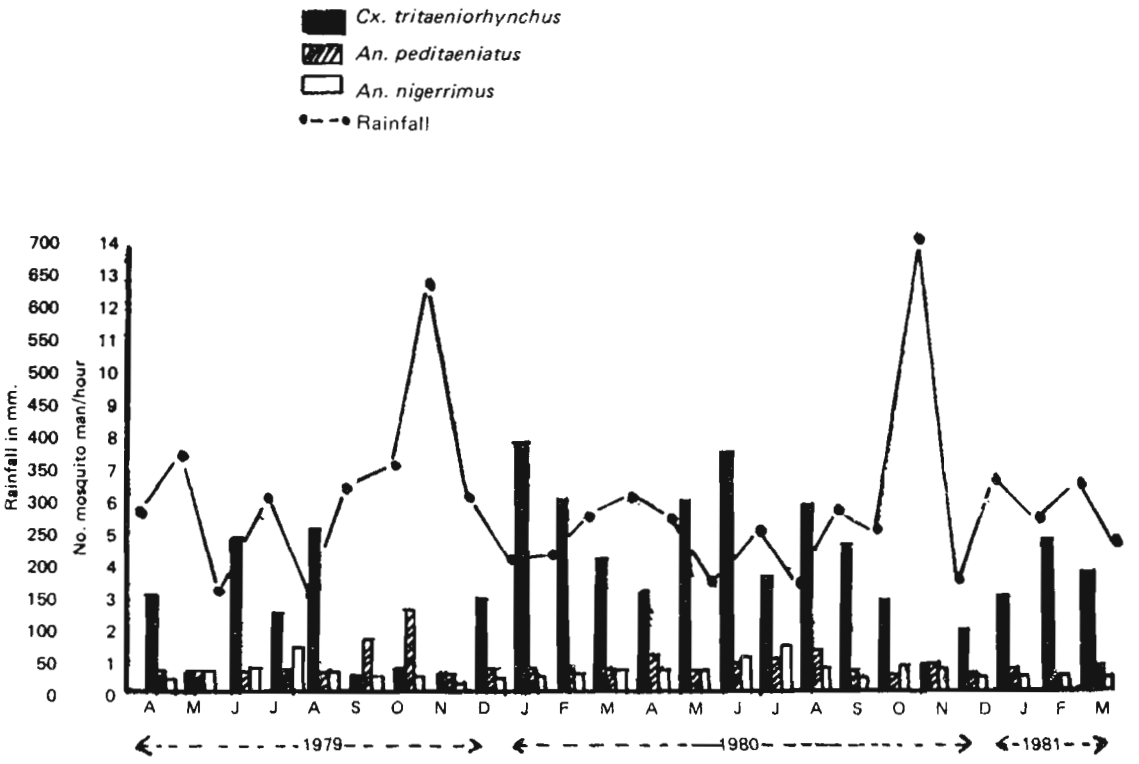


Fig. 3. Seasonal variations of *Culex tritaeniorhynchus, Anopheles peditaeniatus* and *An. nigerrimus* in Gunung Agung village, Southeast Bengkulu, Sumatera, Indonesia.



on the other hand, from both Keban Agung and Gunung Agung (Figs. 4 & 5), the parous rates did not show any correlation with either density or rainfall; the correlation coefficient was r = 0.019 and r = 0.290 respectively. Similarly, no correlation was also observed between parous rates and rainfall. The correlation coefficient test was r = 0.265 and r = 0.006 respectively.

DISCUSSION

Mosquitoes surveys carried out in and around Bengkulu city by Soegiarto (1959) recorded 40 species of 10 genera, *Megarhinus, Harpagomyia, Tripteroides, Uranotaenia, Ficalbia, Mansonia, Coquilletidia, Aedes, Armigeres,* and *Culex*. In the present study six genera with 32 species were examined in the two villages in rural environments (Table 1). Of these, 34 % of the 32 species examined were *Anopheles* spp. of which Soegiarto (1959) did not examine any.

Suzuki et al., (1981) incriminated *Mansonia* spp. as vectors of periodic *Brugia malayi* in Bengkulu and Lien et al. (1975) found *Ma. uniformis* as a potential vector of *B. malayi* in North Sumatera. Except for studies mentioned above, little work has been done on the vectors of filariasis in Sumatera. In other parts of Indonesia, *Cx. quinquefasciatus* has been incriminated as vector of *Wuchereria bancrofti* in Jakarta (Lie et al., 1960), and in New Guinea (Iyengar, 1961). Brug and de Rook (1930) and Raghavan (1961) incriminated *An. barbirostris, An. minimus, Ma. annula-*

Fig. 4. Parous rate of *Anopheles nigerrimus* and *An. peditaeniatus* in Keban Agung village, Southwest Bengkulu, Sumatera, Indonesia.

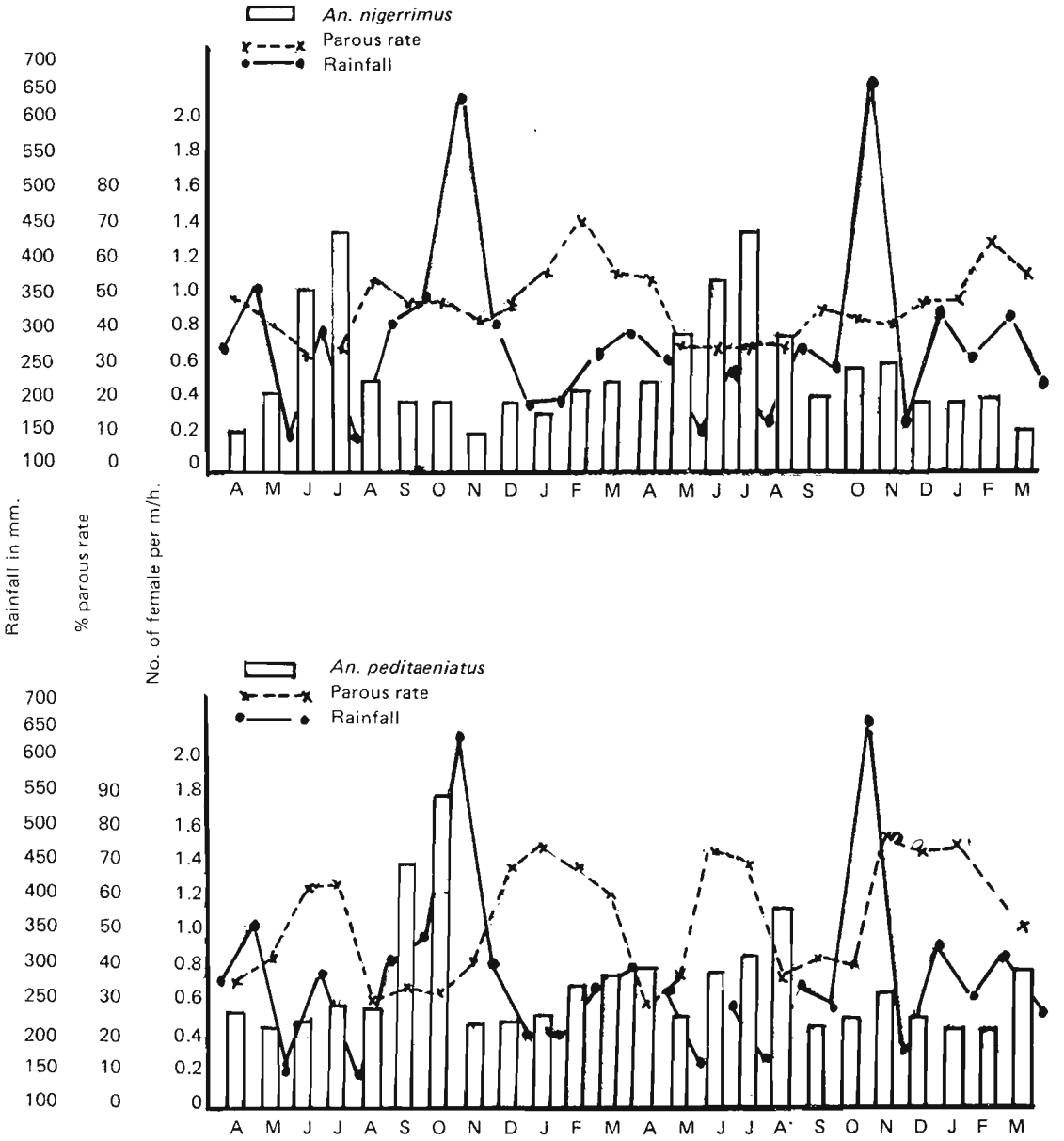
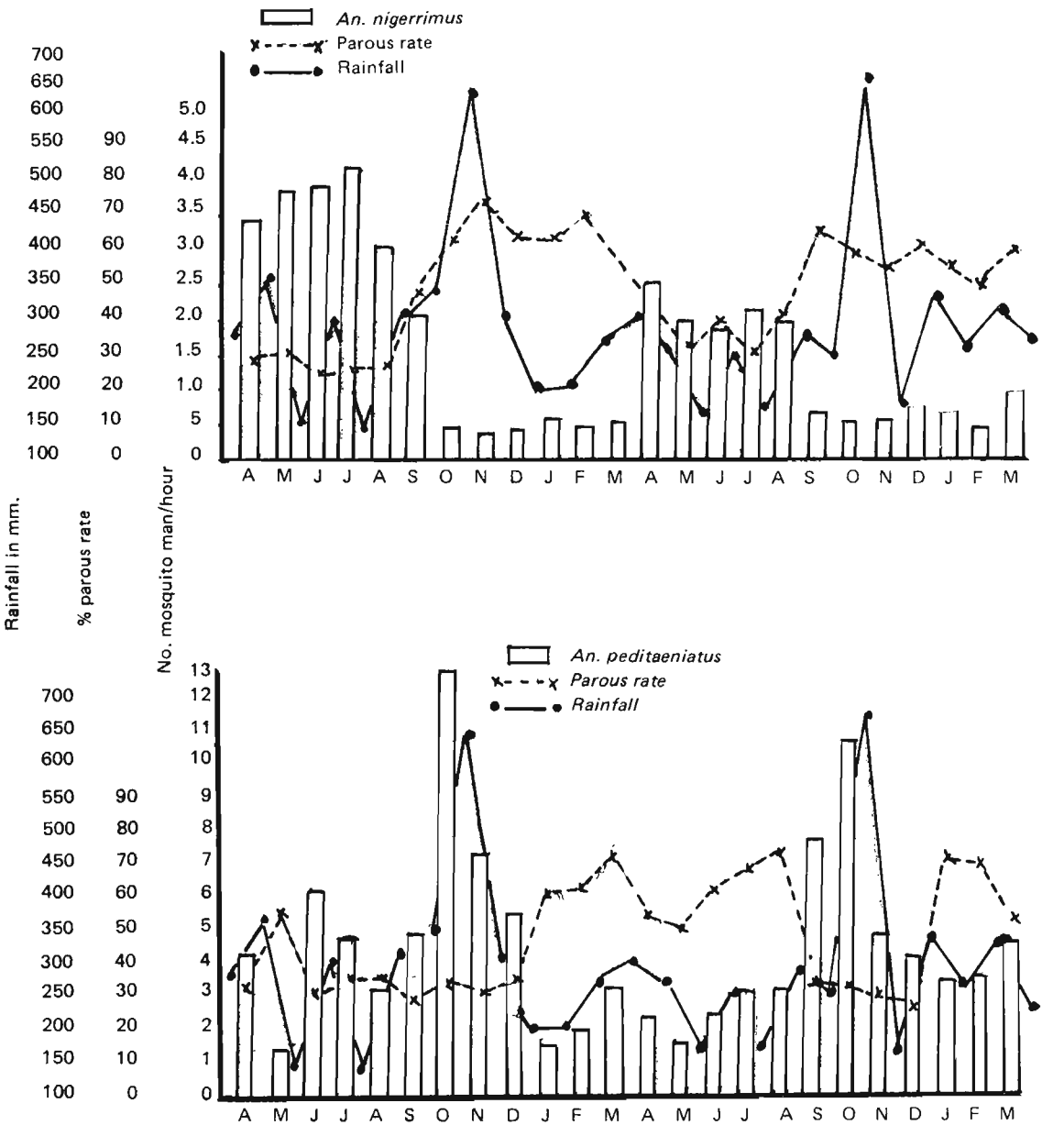


Fig. 5. Parous rate of *Anopheles nigerrimus* and *An. peditaeniatus* in Gunung Agung village, South-east Bengkulu, Sumatera, Indonesia.



ta, Ma. dives/bonneae, Ma. indiana and *Ma. uniformis* as vectors of nocturnal periodic *B. malayi* in certain parts of Indonesia, and Partono et al. (1972) incriminated *An. barbirostris* as a vector in South Sulawesi. In the present studies we found nearly all of these mosquito species prevalent in these two villages of South Bengkulu, Sumatera, Indonesia.

An nigerrimus and *An. peditaeniatus* have been implicated as potential vectors of nocturnal periodic Brugia malayi in Bengkulu, Sumatera by Suzuki et al (1981). *Cx. tritaeniorhynchus* is an important vector of Japanese *B. encephalitis* where the virus was isolated from this mosquito in Kapuk, Jakarta (Van Peenen et al., 1975) and in a small village of Rancabungur, near Bogor, West Java (Van Peenen et al., 1975a).

The nocturnal outdoor catches in Keban Agung were two times higher than indoor catches, while no significant difference was observed between outdoor and indoor catches in Gunung Agung. This could be due to the topography of Gunung Agung which is at a higher altitude with the structures of the houses more open than that of Keban Agung; the latter is situated in a flat low land and the houses are more enclosed. The studies also revealed that among the mosquito fauna in the two villages examined a higher percentage consisted of *Cx. tritaeniorhynchus,* followed by *Mansonia* spp., particularly *Ma. bonneae* and *Ma. annulata.* Among the *Anopheles* spp., *An. peditaeniatus* and *An. nigerrimus* were predominant.

The seasonal variation of *Cx. tritaeniorhynchus* in both study areas was negatively correlated with the monthly rainfall with two distinct density peaks. The seasonal variation of *An. peditaeniatus* exhibits no significant correlation with rainfall, but a distinct peak density was observed in Keban Agung which was absent in Gunung Agung. *An. nigerrimus* neither shows any seasonal variation nor peak density in either of the study areas.

The examination of the parity of both *Anopheles* spp. reveals that rainfall has no influence on the parous rates of these mosquitoes. The non-correlation of *An. peditaeniatus* either with rainfall or density is difficult to explain. It could probably be due to a consistent migration of this species in both these areas from and to surrounding habitats. As regards *An. nigerrimus,* though it was not positively correlated with density, there was a tendency of an inverse correlation of this species in both villages. The generally low parous rates of these two *Anopheles* spp. suggest that the monthly samplings consisted of more young mosquitoes than older adults, and it could also be due to some physical factors unknown to us.

SUMMARY

A total of 46,975 mosquitoes comprising 6 genera with 32 species were obtained through regular nocturnal landing collections for a period of 24 months from Keban Agung and Gunung Agung. *Mansonia* spp comprised 37.0 %, *Anopheles* spp 19.2 %, *Coquilletidia* spp 1.7 %, *Culex* spp 40.8 %, *Aedes* spp 1.1 % and *Armigeres* spp. 0.2 % of the total catches.

Density of mosquitoes spp was shown to be significantly higher in Keban Agung than in Gunung Agung. Outdoor landing collections of mosquitoes were significantly higher than indoor collections in Keban Agung, but in Gunung Agung no marked difference was observed between the two collecting methods.

Seasonal studies of *Culex tritaeniorhynchus, Anopheles peditaeniatus* and *An. nigerrimus* in Keban Agung and Gunung Agung villages, Bengkulu revealed that *Cx. tritaeniorhynchus* was correlated with monthly rainfall, not so with the two *Anopheles* species. There were two distinct peaks for *Cx. tritaeniorhynchus* and neither for *An. negerrimus* nor *An. peditaeniatus.* Parity studies of both *Anopheles* species were found neither correlated with rainfall nor density.

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